

1 What is claimed is:

2 1. An electrically programming & sensing unit for a field repairable system-on-a-
3 chip (SOC) device, said electrically programming & sensing unit comprising:

4 a diode such that a cathode of said diode is connected to a VDD power;

5 an electrically programmable element with a first end connected to an anode of said
6 diode and to a VPP power;

7 a pull-down transistor configured to conduct current from said VDD power or from
8 said VPP power to ground through said electrically programmable element when turned on;

9 a latch configured to latch a value from a second end of said electrically
10 programmable element; and

11 a multiplexor configured to receive a set of external inputs and to control the
12 operation of said pull-down transistor based on said set of external inputs.

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14 2. The electrically programming & sensing unit of claim 1, wherein said
15 electrically programmable element has an initial state that is one of a high resistance and a
16 low resistance and has a programmed state that is the other of said high resistance and said
17 low resistance.

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19 3. The electrically programming & sensing unit of claim 2, wherein a turn-on
20 resistance of said pull-down transistor is substantially at least 10 times of said low resistance
21 and is substantially at maximum $1/10^{\text{th}}$ of said high resistance.

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1 4. An electrically programmable circuit for a field repairable system-on-a-chip
2 (SOC) device, comprising:

3 a high voltage generator configured to supply a VPP power in response to a
4 program_enable signal;

5 a scan chain configured to receive address bits indicating whether a redundant row or
6 a column needs to be activated;

7 an electrically programming & sensing unit configured to receive a signal from said
8 scan chain, said program_enable signal, and a power-on-reset signal such that upon activation
9 of said program_enable signal, said electrically programming & sensing unit further
10 configured to be programmed in response to said signal from said scan chain indicating a
11 defective row or column should be fixed; and

12 a fuse-switch configured to receive an output of said electrically programming &
13 sensing unit such that said electrically programming & sensing unit is able to
14 activate/deactivate said fuse-switch.

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16 5. The electrically programmable circuit of claim 4, further comprises a feedback
17 connection from an output of said electrically programming & sensing unit to said scan chain.

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19 6. The electrically programmable circuit of claim 4, wherein said electrically
20 programming & sensing unit comprises:

21 a diode such that a cathode of said diode is connected to a VDD power;

22 an electrically programmable element with a first end connected to an anode of said
23 diode and to said VPP power;

1 a pull-down transistor configured to conduct current from said VDD power or from
2 said VPP power to ground through said electrically programmable element when turned on;
3 a latch configured to latch a value from a second end of said electrically
4 programmable element; and
5 a multiplexor configured to:
6 receive said program_enable signal and said signal from said scan chain; and
7 output a signal which follows said signal from said scan chain to said pull-
8 down transistor upon activation of said program_enable signal.

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10 7. The electrically programmable circuit of claim 6, wherein said multiplexor is
11 further configured to:

12 receive said power-on-reset signal; and
13 output a signal which follows said power-on-reset signal to said pull-down transistor
14 upon deactivation of said program_enable signal.

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16 8. The electrically programmable circuit of claim 6, wherein said electrically
17 programmable element has an initial state that is one of high resistance and low resistance
18 and has a programmed state that is the other of said high resistance and said low resistance.

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20 9. The electrically programmable circuit of claim 8, wherein a turn-on resistance
21 of said pull-down transistor is substantially at least 10 times of said low resistance and is
22 substantially at maximum $1/10^{\text{th}}$ of said high resistance.

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1 10. The electrically programmable circuit of claim 6, wherein said pull-down
2 transistor is an NMOS transistor

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4 11. The electrically programmable circuit of claim 4, wherein said fuse-switch
5 comprises:

6 a fuse; and

7 a transistor configured to conduct current through said fuse when activated.

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9 12. The electrically programmable circuit of claim 11, wherein said transistor of
10 said fuse-switch is one of NMOS, PMOS, and bipolar transistor.

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12 13. The electrically programmable circuit of claim 4, wherein said scan chain
13 comprises a plurality of flip-flops.

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15 14. A field-repairable system-on-a-chip (SOC) device, comprising:
16 at least one of a plurality of redundant rows and a plurality of redundant columns,
17 wherein each of said redundant row or said redundant column includes a plurality of fuse
18 boxes;

19 a plurality of usage indicators configured to indicate that corresponding redundant
20 rows or corresponding redundant columns are in use;

21 a fuse map sensing circuit configured to sense and save data of said plurality of usage
22 indicators; and

23 a fuse map scan chain configured to send out data sensed by said fuse map sensing
24 circuit.

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15. The field-repairable SOC device of claim 14, wherein each of said fuse boxes for said redundant rows and said redundant columns includes:

- a fuse-switch; and
- an electrically programming & sensing unit configured to control said fuse-switch.

16. The field-repairable SOC device of claim 14, wherein each of said usage indicators comprises a fuse.

17. The field-repairable SOC device of claim 14, wherein said fuse mapping circuit comprises:

- a latch configured to latch value of said usage indicator; and
- a transistor configured to cause said latch to latch the value of said usage indicator.

18. The field-repairable SOC device of claim 14, further comprising:
a high voltage generator configured to supply a VPP power in response to a program_enable signal;

a scan chain configured to receive address bits indicating of word and bit lines that should be corrected; and

a plurality of electrically programmable circuits, wherein each of said electrically programmable circuit comprises:

- an electrically programming & sensing unit configured to receive a signal from said scan chain, said program_enable signal, and a power-on-reset signal such that upon activation of said program_enable signal, said electrically programming &

1 sensing unit further configured to be programmed in response to said signal from said
2 scan chain indicating a defective row or column should be fixed; and
3 a fuse-switch configured to receive an output of said electrically programming
4 & sensing unit such that said electrically programming & sensing unit is able to
5 activate/deactivate said fuse-switch.
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7 19. The field-repairable SOC device of claim 18, wherein said electrically
8 programming & sensing unit comprises:

9 a diode such that a cathode of said diode is connected to a VDD power;
10 an electrically programmable element with a first end connected to an anode of said
11 diode and to said VPP power;
12 a pull-down transistor configured to conduct current from said VDD power or from
13 said VPP power to ground through said electrically programmable element when turned on;
14 a latch configured to latch a value from a second end of said electrically
15 programmable element; and
16 a multiplexor configured to:
17 receive said program_enable signal and said signal from said scan chain; and
18 output a signal which follows said signal from said scan chain to said pull-
19 down transistor upon activation of said program_enable signal.
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21 20. The field-repairable SOC device of claim 19, wherein said multiplexor is
22 further configured to:

23 receive said power-on-reset signal; and

1 output a signal which follows said power-on-reset signal to said pull-down
2 transistor upon deactivation of said program_enable signal.

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4 21. A method to package a field-repairable system-on-a-chip (SOC) device at a
5 factory, comprising:

6 repairing said SOC device, using one or both of redundant rows and columns, prior to
7 packaging said device;

8 marking usage of all redundant rows and columns;

9 retesting said SOC device; and

10 packaging said SOC device in response to said SOC device completing said retesting
11 step satisfactorily.

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13 22. The method of claim 21, wherein said repairing step comprises performing
14 laser blown repairs on said redundant rows and columns.

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16 23. The method of claim 21, wherein said marking step comprises blowing usage
17 indicators corresponding to said redundant rows and columns.

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19 24. A method to field repair a field-repairable system-on-a-chip (SOC) device at a
20 factory, comprising:

21 performing a diagnostic test on said SOC device;

22 identifying unused redundant rows and columns;

23 electrically programming any of said unused redundant rows and columns; and

24 retesting said SOC device.

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2 25. The method of claim 24, further comprising usage marking any used
3 redundant rows and columns during the electrically programming step.

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5 26. The method of claim 24, wherein said electrically programming step
6 comprises:

7 shifting in an address of a defective row or column to a scan chain; and

8 applying a programming power VPP to a electrically programming and sensing unit

9 associated with said address shifted in said scan chain.